Training Opportunity for Luxembourgish Trainees

Reference	Title	Duty Station
LU-2019-TEC-EFE	Radiofrequency technologies, equipment and techniques	ESTEC

Overview of the unit's mission:

The Radio Frequency Payloads & Technology Division (TEC-EF) is responsible for RF payloads, instruments and technologies for space and ground applications, including all equipment having a Radio Frequency space/ground interface and its associated Laboratories. The division supports the definition, specification and development/ procurement of laboratories for either ESA projects and technology programmes or external customers.

The division consists of four sections covering the following domains:

- Payloads with RF interface for telecommunication and navigation exploiting different technologies (e.g. analogue, digital, optical) including design, performance analysis tools and testing;
- Earth observation and scientific RF active and passive instruments design, performance analysis, engineering & testing up to sub-millimetre waves;
- Wave-propagation and interaction relevant to space communications, navigation and remote sensing, including interference and regulatory aspects;
- Antenna systems, architecture, technologies and techniques for all space applications, including space vehicle TT&C and user segment terminals, as well as antenna engineering and RF testing of antenna and material;
- RF equipment and technologies, including RF passive technologies, RF active technologies, vacuum electronics and high power RF phenomena (multipactor, corona and passive intermodulation).
- Time and frequency references, modelling, design tools, measurements, performance characterisation and calibration techniques.

Overview of the field of activity proposed:

Within the RF equipment and technologies section, the incumbent will have the opportunity to work in **one** of the following disciplines, depending on her/his background:

1) RF passive technologies:

   Space business has been traditionally conservative. However, in the last years there has been a profound change affecting the sector at all levels, from system to equipment. This is also impacting the way RF passive technologies are designed, manufactured and test. Cost, time to market and mass production are at the moment three of the main important drivers together with good RF performance. Additional effort in the R&D for RF passive technologies is required in order to cover short and long term needs such as miniaturized microwave filters, improved integration capabilities with active stages and inexpensive passive redundancy implementation.

   The proposed training will consist of analysis, design, circuit and/or full electromagnetic simulations and experimental validation in breadboards for highly integrated multifunctional RF passive modules.

2) Additive manufacturing (AM) for RF parts:

   AM has matured over the last years up to a point where it becomes a real manufacturing alternative for RF parts. However, the current approach is mostly replicating conventional topologies mainly oriented for classical manufacturing techniques (e.g. milling). Optimized parts can be built by defining new design and manufacturing rules dedicated and adapted for this specific manufacturing approach. The definition of manufacturing rules has to be done understanding deeply the advantages and constrains provided by the manufacturing method. This training opportunity aims to work in a multi-disciplinary environment with material, processes and RF aspects and will try to master some AM approaches to get optimised design and, in general, new design/manufacturing rules for RF/Microwave parts.

3) Passive Intermodulation (PIM) prediction and mitigation techniques:

The high RF power trend of the satellite payloads impose challenging requirements for Passive Intermodulation (PIM) on the output RF passive hardware. The main goal of the training activity will be the investigation of PIM effect and identification of suitable procedures to mitigate PIM generation. Modelling of PIM using advanced non-linear modelling theory will also be considered. The training will study PIM sources, parameters affecting PIM (temperature, pressure, power, frequency, PIM order, etc.) and mitigation techniques, supported by measurements.

4) RF active technologies:

Investigating RF transistor optimum loading conditions by means of passive, active and hybrid load-pull is key for developing amplifiers with optimum output power and efficiency. This is particularly important for Ka-Band multi-beam active antennas where high efficiency is required. The proposed training will support the Section's active component characterisation activities using state-of-the-art semiconductor technologies, with additional work towards high efficiency architecture concepts and designs.

5) Time and Frequency (T&F) subsystems and equipment:

Characterization and performance analysis of T&F equipment and subsystems (RF frequency converters, oscillators, synthesiszers, and atomic clocks) in a wide range of operational and environmental conditions as well modelling using design and simulation tools for prediction and performance optimisation. The proposed training opportunity will include the development of new tests beds and characterization techniques as required for the validation and verification of new equipment and subsystems technologies, with additional work towards high efficiency architecture concepts and designs.

6) High power RF breakdown - Multipactor:

Currently the prediction of high power RF breakdown is performed assuming unmodulated signals and, in most of the cases, single carrier scenarios. In addition, material models used during the prediction are based on strong assumption. This training opportunity aims to revisit the assumptions considered during the prediction phase and check their validity when considering real conditions in terms of signal excitation, matching, material modelling, etc. A reliable approach to predict multipactor breakdown in this case would give a unique possibility to reduce testing requirements, resulting in a significant risk, cost and schedule reduction.

7) Advanced Multiphysics modelling of high power passive components:

Performance of multi-functional parts (e.g. RF, thermal, mechanical) are commonly checked separately, taking multiple steps to achieve an optimized solution. However, a single parameter could impact multiple functions in a device and the multi-physic approach will lead to better solution in shorter time. Examples are, for instance, thermal compensated filters or high power ferrite-based components where it is not possible to predict the final solution by simple extrapolation since, in most of the cases, non linear behaviours are involved. This training opportunity will focus on the development of efficient multi-physic design processes of high power parts.

Required education:

Applicants should have just completed, or be in their final year of a University at Masters Level (or equivalent) in a technical or scientific discipline, preferably in Telecommunications/Electrical/Electronic/Microwave Engineering or Physics.

Knowledge of design tools such as ADS, MWO, HFSS, CST, COMSOL or MICIAN, as well as experience in RF testing and programming e.g. MATLAB would be an asset.